MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

TCV3501 – COMPUTER VISION AND IMAGE UNDERSTANDING

(All sections / Groups)

12 OCTOBER 2016
2.30 p.m. – 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages with 4 Questions only.
2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1

a) Describe an **indexed** colour image. What is its main advantage compared to a full RGB colour image?

[2 marks]

b) A 1024x1024 pixels 8-bit grayscale image is subsampled down to size 32x32 pixels. Keeping the number of gray levels at 256, how many times smaller is the image file size after sub-sampling?

[2 marks]

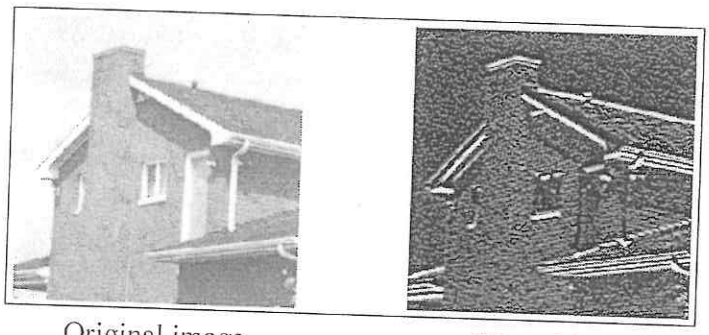
c) Apply a 3x3 averaging filter on the image below, using zero padding along the borders. Draw the resulting filtered image (ensure that the final values are rounded to the nearest integer).

[3 marks]

180	210	112
8	177	97
70	101	195

d) Write an Octave/Matlab program to filter the original image `'house.png'` using a horizontal Sobel edge filter mask. Show both the original and filtered image side by side in the same figure.

[3 marks]



Original image Filtered image

Continued...

Question 2

a) Describe the Laplacian-of-Gaussian (LoG) filter, and explain how edges are detected using this filter.

[2 marks]

b) What is the purpose of performing non-maximum suppression in edge detection?

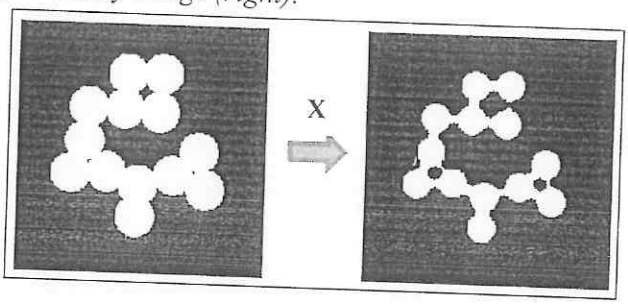
[1 mark]

c) Label the region blobs in this binary image based on connected components. Assume that pixels are 4-connected as neighbors.

[3 marks]

1	1	0	1	1	0
0	1	1	1	0	1
1	1	1	1	0	0
0	1	1	0	1	1
1	1	1	1	0	1
0	0	0	0	0	0

d) The following binary image *(left)* undergoes a morphological operation **X** to produce the output binary image *(right)*.



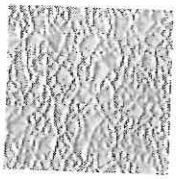
(i) Identify the morphological operation **X**.

(ii) Notice that **X** did not manage to maintain the original size of the circular objects. Propose another morphological operation instead of **X** that might be able to avoid this problem.

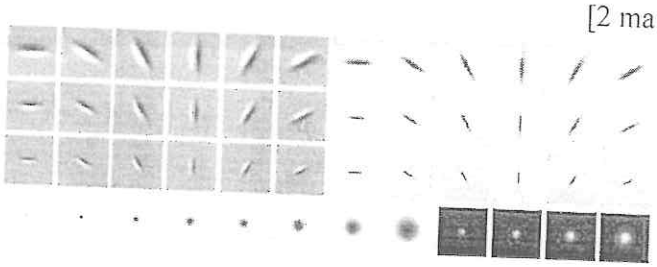
[2 marks]

e) Explain how the Leung-Malik (LM) filter bank can be used to extract and represent textures in an image.

[2 marks]



Texture



LM filter bank

Continued...

Question 3

a) What are the **three** color components in the HSV color model, and what do they measure?

[3 marks]

b) Convert the following RGB image (with 2-D image for each channel) into a grayscale image.

[2 marks]

R =

33	20	30
12	100	255
4	53	60

G =

120	67	211
111	156	255
98	140	198

B =

0	5	200
5	5	255
0	5	200

c) The following questions are on grouping/clustering:

i) Describe the steps of the **k-means clustering** algorithm.

[3 marks]

ii) Give an example of a computer vision application where clustering is important. Provide some details as to *how* clustering is used in your example.

[2 marks]

Continued...

Question 4

a) Define **optical flow**, and also briefly describe **two** key assumptions it makes.

[2 marks]

b) (i) Explain the use of **feature detectors** and **feature descriptors.**

[2 marks]

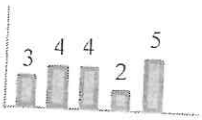
(ii) Then, elaborate in detail an example application that makes use of both feature detectors and descriptors.

[2 marks]

c) The following questions are on using visual words for image retrieval:

(i) Given a vocabulary of V visual words, compute the similarity score (up to 3 decimal places) between the feature vectors of the two images provided based on the cosine similarity measure:

$$sim(d_j, q) = \frac{\langle d_j, q \rangle}{\|d_j\| \, \|q\|}$$



$V = 5$ visual words

[2 marks]

ii) Calculate the precision and recall scores given a database of various types of object images, including 78 bicycle images, where the image retrieval system manages to retrieve 69 bicycle images from a total of 110 images returned from the search.

[2 marks]

End of Question Paper